ERDC/CHL CHETN-XIV-24
September 2012

US Army Corps of Engineers®

Practical Recommendations for Regional Sediment Management: Lessons Learned at St. Johns County Shore Protection Project

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PURPOSE. This Coastal and Hydraulics Engineering Technical Note (CHETN) provides a description of the St. Johns County, FL, Shore Protection Project (SPP) with focus on Regional Sediment Management (RSM) to illuminate lessons learned to advance the state of RSM application across the US Army Corps of Engineers (USACE).

INTRODUCTION. RSM has been an important part of projects in Florida for the last three decades, and in that time has become integrated in many US Army Corps of Engineers Jacksonville District, Jacksonville, FL (SAJ), projects. Historically, SAJ projects have included various aspects of RSM in project tasks usually in response to some specific project goal, with a more integrated approach emerging over the last decade. The St. Johns County SPP provides a comprehensive example demonstrating application of these RSM principles in SAJ.

Regional Sediment Management is a systems-based approach implemented collaboratively with other federal, state, and local partners. Through RSM approaches, the USACE strives to improve the management and use of sediments within a regional context, considers sediments as a regional resource, and implements adaptive management strategies across multiple projects. These initiatives supports sustainable solutions for navigation and dredging, flood and storm damage reduction, and environmental practices which increase benefits while reducing costs.

Application of RSM is often thwarted by: (1) conflicting goals within the same region, (2) lack of communication, (3) complicated Federal policy, and (4) other project specific factors. As a result, RSM principles are often applied as a "band aid" to projects after much of the planning and design has been completed. This CHETN documents RSM application at St. Johns County, FL, to help guide future projects.

ST. JOHNS COUNTY SHORE PROTECTION PROJECT. St. Johns County is located on the northeast coast of Florida. The county is bounded to the north by Duval County and to the south by Flagler County. The county has approximately 42 miles of Atlantic coastal shoreline along three barrier islands separated by St. Augustine Inlet and Matanzas Inlet. The study region within St. Johns County begins at the northern boundary of the Vilano Beach reach of the St. Johns County Feasibility Study. The region continues along the coast, including the Atlantic Intracoastal Waterway (IWW), St. Augustine Inlet, Anastasia State Park, and ends at the southernmost extent of the St. Augustine Beach reach of the St. Johns County Shore Protection Project. Figure 1 shows the locations of projects throughout St. Johns County.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
SEP 2012		**00-00-2012 to 00-00-2012**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Practical Recommendations for Regional Sediment Management: Lessons Learned at St. Johns County Shore Protection Project	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Army Engineer Research and Development Center,Coastal and Hydraulics Laboratory,3909 Halls Ferry Road,Vicksburg,MS,39180**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**10**	

Figure 1. St. Johns County, FL, area map.

The St. Johns County RSM initiative area includes three Federal Navigation projects: (1) the St. Augustine Inlet, (2) the IWW, and (3) the San Sebastian River. There is currently an authorized shore protection project to the south of the inlet on St. Augustine Beach, and an on-going feasibility study for Hurricane and Storm Damage Reduction north of the inlet. It is the proximity of these projects that provides an ideal site for application of RSM principles. Table 1 lists recent Federal actions in the region.

Table 1. Recent Federal Activities in St. Johns County, FL.

Year(s)	Federal Activity
1996-2001	IWW and Inlet dredging placed on south beaches
2001	RSM Design for St. Augustine Beach Shore Protection Project
2003	Finish Initial Construction of SPP
2004	New Feasibility Study initiated (including north of the inlet)
2004-2005	Damaging hurricane season
2005	Emergency renourishment of St. Augustine Beach
2007	Renourishment plan 2010 meets opposition
2008	RSM Implementation seeks additional sources and the data window expanded for sediment budget refinement
2009-present	Modeling to evaluate sources
2010-present	Optimization of all sources and needs

Historically, there had been no obligation to actively manage St. Augustine Inlet. Dredged material from the shallow-draft channel was disposed in the least costly manner. The most cost-effective alternative was placement of the material on the beach which, from an RSM perspective, also happened to be the preferred alternative. Although the SAJ General Re-evaluation Report (US Army Corps of Engineers 1998) did not specifically discuss RSM, some considerations were applied during the study to help define better placement options.

RSM GOALS. St. Johns County RSM goals are to: (1) supplement natural inlet bypassing, (2) stabilize critically eroding beaches south of the inlet, (3) beneficially use dredged material, (4) improve the Dredged Material Management Plan (DMMP) for the IWW, and (5) link the SPP with the St. Augustine Harbor maintenance. The most tangible benefit identified has been the cost savings of linking the SPP with a navigation project. The cost savings would be realized by needing only a single mobilization and demobilization for the SPP and harbor maintenance. Other benefits include reducing the risk of environmental impact by decreasing the amount of dredging, and ensuring a supply of back-up sources for emergency nourishments, as was needed after the 2005 hurricane season. Figure 2, which shows various areas identified through the conceptual sediment budget that have a sediment surplus or deficit, illustrates potential targets of opportunities and goals for RSM.

The St. Augustine Inlet ebb shoal was the borrow area used for nourishment of the St. Augustine Beach in 2003, and for emergency nourishment in 2005. These efforts resulted in concerns about dredging pressure on the St. Augustine ebb shoal from local property owners and from the Florida Department of Environmental Protection (FDEP). To address concerns about dredging the ebb shoal and making other changes to the region, the sediment sources, pathways, and sinks within the beach and inlet system needed to be illustrated. In addition to addressing stakeholder concerns, the existing sediment budget needed to be updated to reflect construction of the SPP and dredging of the inlet.

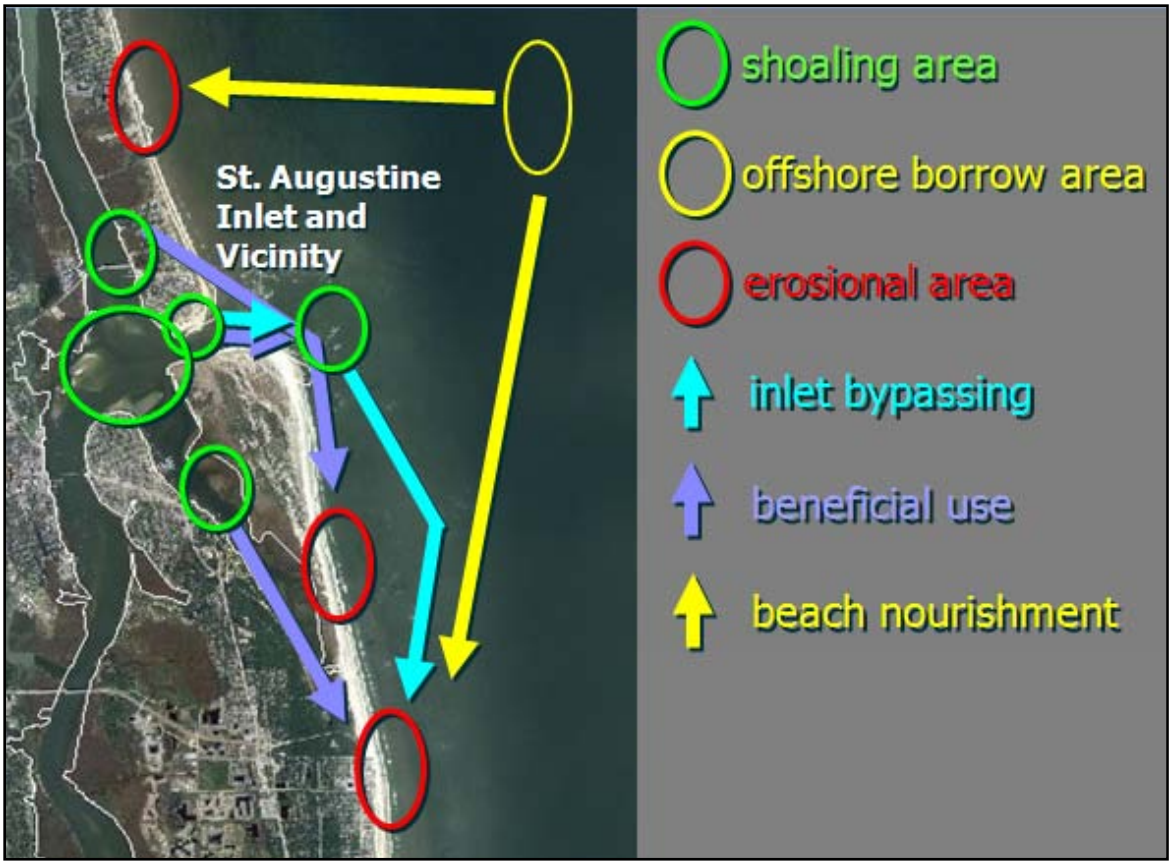

Figure 2. Conceptual sediment sources, pathways, and sinks, St. Augustine Inlet and vicinity.

The Florida Department of Environmental Protection (FDEP) maintains an inlet management plan for St. Augustine Inlet that documents intended management principles (Florida Department of Environmental Protection 1998). To improve the management plan, FDEP has required detailed modeling results to provide a better understanding of physical processes, and to demonstrate the impacts of proposed activities. In response to this need for greater understanding to better manage the inlet and to meet the other stated goals, SAJ has undertaken a rigorous study of coastal processes (described in the following section). This additional analysis, along with improved project communication, led to the recent award of a permit to use the ebb shoal as a borrow source for beach nourishment.

RSM STRATEGY. RSM will identified sediment transport patterns and management alternatives for St. Augustine Inlet, FL, and its vicinity to meet the previously stated goals. The following steps were developed to organize the RSM philosophy and structure the activities required to accomplish these project goals:

- Develop a conceptual sediment budget using historical data to better understand how the system is interacting, by identifying the needs and sources.
- Link navigation maintenance dredging with placement needs to keep sand in the natural system.

- Optimize sediment availability with need within the system based on parameters such as quality, quantity, timing, and location.
- Construct projects by coordinating navigation channel dredging with beach nourishment to share costs for construction equipment mobilization and demobilization.
- Monitor effects.
- Iterate to manage adaptively.

REGIONAL ANALYSES. As new technologies become available to enable a better understanding of regional processes, new opportunities to apply RSM for more sustainable sediment management are continuously being identified. Additionally, stakeholders and partners have started to expect those state-of-the-art analyses to enable better use of regional sediment resources. This sub-section briefly describes regional analyses conducted to inform RSM for the SPP.

The SPP was developed based on a sediment budget developed for the FDEP Inlet Management Plan. This budget determined the volume that should be bypassed from the ebb shoal to assist in meeting the RSM strategy described above. As concerns over ebb shoal dredging developed post-2005, dredging and placement data for all projects within the region were gathered into a Geographic Information System to help identify additional sediment sources for the SPP. This effort identified potential sources and sinks that could be used collectively to better manage sediment (illustrated in Figure 2). Additionally, a sediment compatibility analysis by SAJ (US Army Corps of Engineers 2010a) was conducted to further refine the sources that were better suited to locations in need of sediment (Figure 3).

Compatibility

			St. Johns Beaches			
			South Pontevedra	Anastasia Island	St. Augustine Beach	Summer Haeven Beach
			Y1	Y2	Y3	Y4
St. Johns Borrow Areas	IWW Cut 28	X1	3	4	4	4
	Flood Shoal	X2	2	2	3	1
	Salt Run	X3	???			
	Ebbshoal	X4	2	2	3	1
	Vilano Point	X5	3	1	1	2
	Northern Off-shore Borrow Area	X6	3	2	2	1
	Southern Off-shore Borrow Area	X7	4	1	2	2

1	Best Match
2	Good Match
3	Match
4	No Match

Figure 3. Results of regional sediment compatibility analysis.

A volume change analysis was completed to determine the extent of the inlet's influence on shoreline change by SAJ (US Army Corps of Engineers 2010b). The results showed an influence of the inlet over 8 miles to the north and 4 miles to the south. The inlet location has been changing over the last few decades. Also, reduced sediment bypassing, the amount of sediment available for transport in the system, and other factors have resulted in modified behavior of the coastal system that must be quantified for successful project design and permitting. The volume change analysis was also instrumental in demonstrating that dredging the ebb shoal in 2003 and 2005 did not exacerbate shoreline retreat. This information will revise the initial conceptual sediment budget into an updated regional sediment budget (Legault et al. in preparation).

A two dimensional model of inlet morphology was then developed using the Coastal Inlets Research Program's (CIRP) Coastal Modeling System (CMS) (Sanchez et al. 2011) to better define how much sediment could be mined from the ebb shoal without risk of destabilization, and to further quantify potential impacts to adjacent shorelines. Four scenarios were considered: (1) existing conditions, (2) dredging 1.5 million cu yd, (3) dredging 3 million cu yd, and (4) dredging 4 million cu yd. The results showed little volumetric or morphologic change except for the 4 million cu yd scenarios. The 4 million cu yd scenario resulted in some morphologic changes although it did not indicate a likely collapse of the ebb shoal complex. Figure 4 shows example CMS calibration results, which document that the model represents trends in short-term evolution of the shoal and channel (regions 1, 2, and 5) while trends in the nearshore (labeled 3 and 4) are less well captured.

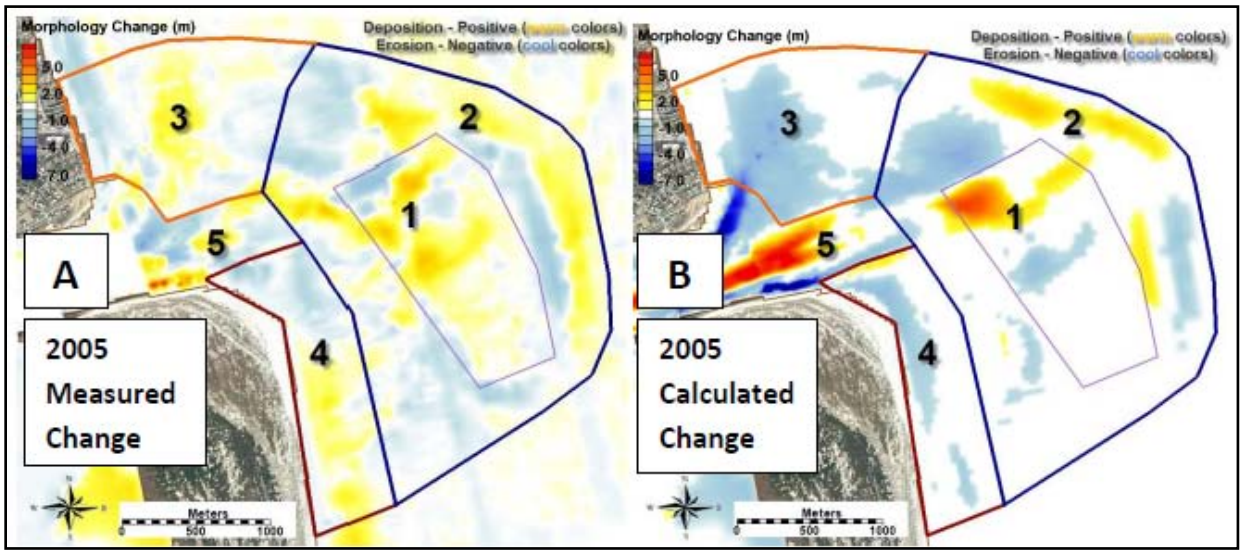

Figure 4. Comparison of measured 2005 bathymetry (A) with CMS calculated 2005 bathymetry (B).

The next step planned to improve understanding of regional processes in St. Johns County is to couple the data and CMS model results with the GenCade (Hansen et al. 2011) model. GenCade simulates long-shore and cross-shore sediment transport processes including morphologic responses to engineering actions, and interactive shoreline, dunes, and inlet evolution, from regional and long-term perspectives. GenCade allows the input of dredging and placement activities, and calculates the resulting impact on adjacent shorelines. Alternatives will then be

developed to evaluate multiple proposed dredge and placement actions to ascertain beneficial use of the material.

St. Johns County SPP Challenges. Challenges experienced during the St. Johns County SPP have exceedingly enlightening for other RSM activities in SAJ. Although the challenges were intense, efforts necessary for success have resulted in better relationships within the region, and are already improving SAJ ability to execute projects. Some of those challenges are:

- **Communication with stakeholders.**
  - Identifying all the stakeholders was difficult. Obvious stakeholders for the SPP were invited to early project meetings to ensure total transparency. Unfortunately, some key stakeholders were inadvertently omitted from these early meetings because District team members did not fully understand the inherent interests these key stakeholders had in the SPP. This led to a bit of consternation among all stakeholders, as well as internal USACE discomfort.
  - Effective project communication is primarily the responsibility of the Project Manager (PM). PMs often have competing issues on a project, thus leaving the engineers and planners to focus on the RSM technical details. Some PMs may initially be reluctant to engage in RSM discussions if they are not fully cognizant of the project sponsor's interest. In the case of the St. Johns region, as inlet conditions evolved, some projects that were initially not included sought involvement. All potential stakeholders should be involved through emails, personal conversations, and meeting invitations from the beginning of the process.
- **USACE culture.**
  - While SAJ engineers, planners, and scientists think from a regional context, it is sometimes difficult to fully and effectively communicate the value of RSM to others. Additionally, District Operations and Maintenance, and Construction, personnel have historically been less engaged in RSM activities than others due to the inherent nature of the activities.
  - RSM seeks to cross project-specific boundaries although authorities and funding remain project-centric. Authorities and funding are the main prerequisites to actually executing a job. RSM implementation is often handicapped in this regard. For instance, USACE often has the authority to dredge a channel, and receives funding to do so. However, the authority rarely mentions the surrounding coastal system, and the best use of the dredged material to maintain that system. Funds are spent in accordance with the authority and, due to schedules and/or contract requirements, are often difficult to combine with funds from other project authorities within the same coastal system.

General Recommendations for Practical Application of RSM. Success of any RSM initiative hinges on: (1) good communication with the appropriate **people**, (2) understanding the **physics** of the regional processes and how proposed works will modify those processes, and (3) appreciating how to navigate the USACE permitting and funding **policies**. Figure 5 shows this triad necessary for RSM success.

Some general recommendations that will improve RSM success on other initiatives and District projects are:

- Apply available technology to better understand and quantify processes on a regional scale.
  - Application of state-of-the-art technology can improve project communication, enlighten stakeholders, and is often required for obtaining needed permits.
- Develop a stakeholder/partner communication plan.
  - This plan should detail how the USACE stakeholders, and partners across the region will be communicate.
  - It should be based on an understanding of what motivates each stakeholder and partner.
  - It should emphasize how each stakeholder and partner can benefit by an RSM strategy.
- The RSM strategy should be included in the Project Management Plan.
  - This RSM strategy should include the stakeholder/partner communication plan and an internal communication plan, in addition to the technical description of the identified activities.
- RSM tasks including internal/external coordination should be specifically delineated in any technical Statements of Work prepared.
- A regional RSM manager should be identified to assist with improving communication across projects within the same region.

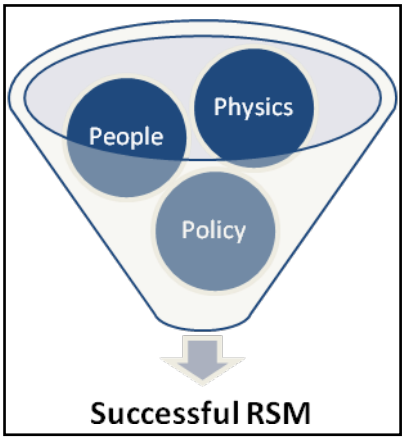

Figure 5. Triad of RSM success.

- Every effort should be made to quantify RSM activities. Typical metrics that can be applied to gage success include:
  - Volume of sediment
    - Used beneficially
    - Not placed in a confined disposal facility, offshore, or otherwise lost from the system
  - Dollars spent or saved
  - Relationships created or improved
  - Public awareness/Education improved
- New economic tools to quantify life cycle savings attributable to RSM are needed.
  - One such tool should enable economic justification based on multiple projects across a region. This new tool may result in a Regional NED plan that is not necessarily the least expensive plan for any one particular project, but is the most economical plan for the Federal government overall. Potentially, regional project authorities and funding could follow.

CONCLUSIONS. This Coastal and Hydraulics Engineering Technical Note (CHETN) provides a brief overview of RSM as it was applied for the St. Johns County SPP. Challenges experienced during this effort were investigated to develop general recommendations that will improve RSM applications across the USACE.

ADDITIONAL INFORMATION. This CHETN was prepared as part of the Regional Sediment Management (RSM) program, and was written by Robert C. Thomas, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, MS; and Matthew H. Schrader, Jason A. Engle, and Dr. Kelly R. Legault, US Army Engineer District, Jacksonville, FL (SAJ). Information presented in this CHETN is based on personal interviews with SAJ personnel as well as published and draft reports on the subject. Additional information pertaining to RSM can be found at the RSM web site http://rsm.usace.army.mil

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This ERDC/CHL CHETN-XIV-24 should be cited as follows:

> Thomas, R. C., M. H. Schrader, J. A. Engle, and K. R. Legault. 2011. Practical recommendations for regional sediment management: Lessons learned at St. Johns County shore protection project. Coastal and Hydraulics Engineering Technical Note ERDC/CHL CHETN-XIV-24. Vicksburg, MS: US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory.
> http://chl.erdc.usace.army.mil/library/publications/chetn/pdf/chetn-xiv-24.pdf

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ACRONYMS AND ABBREVIATIONS.

Term	Definition
CHETN	Coastal and Hydraulics Engineering Technical Note
CHL	Coastal and Hydraulics Laboratory
CMS	Coastal Modeling System
DMMP	Dredged Material Management Plan
ERDC	Engineer Research and Development Center
FDEP	Florida Department of Environmental Protection
IWR	Institute for Water Resources
IWW	Intracoastal Waterway
PM	Project Manager
RSM	Regional Sediment Management
SAJ	[US Army Corps of Engineers] South Atlantic Division, Jacksonville District
SPP	Shore Protection Project
USACE	US Army Corps of Engineers